

"Probes to Saturn and Beyond" Panel Discussion Report

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Submitted by
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Panel Members: Sushil Atreya (U. Michigan, Chair), Alessandro Atzei (ESTEC), Tibor Balint (JPL), Christian Cazaux (CNES), Jean-Pierre LeBreton (ESTEC), Paul Mahaffy (GSFC), Thomas Spilker (JPL). Absent: Scott Bolton (SWRI).

The panel discussion focused on

- (1) Scientific justification for probe missions to the giant planets
- (2) Potential architecture for a Saturn probe mission
- (3) Status of key enabling technology
- (4) Importance of integrated systems approach
- (5) Potential areas of international collaboration

The panel members were selected on the basis of their expertise in one or several of the above areas. The panel discussion lasted approximately one hour, with valuable input from the audience. The main findings of the discussion are summarized below.

The fundamental questions of the formation of the giant planets and the origin of their atmospheres require determination of the heavy element abundances (mass $> {}^4\text{He}$). With the exception of carbon (in CH_4), such elements can be accessed *only* by in situ measurements from entry probes.

Comparative planetology of the gas giants (Jupiter and Saturn) and the ice giants (Uranus and Neptune) is essential for constraining fully the models of the origin and evolution of the solar system. Hence, probes are needed at all four giant planets.

A Saturn flyby mission which combines the capabilities of entry probes and microwave radiometry (MWR) must be considered as the highest priority giant planet mission for the near term (next 5-7 years). Recent studies done at JPL indicate that such a mission is very promising as a New Frontiers (NF) class (\$700 Million) mission.

A minimum of two shallow probes will be required to meet the science goals of the Saturn mission, and they can be accommodated under the NF cost cap. In order to achieve reasonable spatial resolution, preliminary studies indicate that the MWR experiment will need to be carried out from the probes, rather than from the flyby spacecraft. Studies done at JPL indicate that the mission architecture requires flying the spacecraft at $2R_S$ or beyond, which would result in essentially planetary-scale spatial resolution, i.e. only disk-average results from MWR if mounted on the spacecraft. This needs to be looked into more carefully.

Direct-to-earth (DTE) transmission of data from the probes has been found not feasible. Besides not buying us much, even if possible, it would be very risky as the only means of data transmission, considering the possibility of single point failure. Nevertheless, it is desirable to include DTE as an "added" capability, and to ensure that enhancement to the DSN, SKA capability, etc. are being carried out in a timely manner.

For the longer term, Flagship class (\$1 billion plus) missions to Neptune – Neptune polar orbiter with probes, with an option of a Triton lander – and Uranus orbiter with probes are required. A Jupiter multiprobe mission will benefit from the results of Juno; therefore its architecture is best decided after 2016/2017.

Thus, the IPPW-4 conclusion for future exploration of the giant planets is consistent with that of the OPAG (Outer Planet Assessment Group of NASA). For all probe missions, an integrated payload system approach should be looked into seriously, for savings in resources, minimizing complexity, and improving performance and capability. Presently, there are limits to such an approach, so early investment in technology development will be required. Investment is also required for communications, heat shield development and characterization, including the Giant Planet

Facility (except for the Saturn probes, for which sufficient left over material from the Galileo probe seems to exist), etc.

Finally, all agreed international collaboration on the probe missions is the way to go. However, ITAR rules have made such a collaboration highly challenging. A "clean interface" of hardware approach may still allow

meaningful international collaboration. Some possibilities considered are in the area of solar panels, communication hardware, star trackers, etc. This will need to be settled and agreed upon rather rapidly, in order to meet the proposal and schedule timelines. The Panel strongly endorsed continued preparatory work for a Saturn probe with microwave mission, as an immediate goal for the near term.